



Italian National Agency for New Technologies,
Energy and Sustainable Economic Development

Energy poverty: A "multifaceted" cornerstone for a sustainable and inclusive recovery (and growth)

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Session 11*

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- ❑ **1. Research question and hypothesis**
 - A quest for definition and measure
 - From ex-post energy poors to ex-ante energy vulnerables
- ❑ **2. Method and results**
 - Variables, formulas, models, data...
- ❑ **3. Closing remarks**
 - Achievements and future improvements...

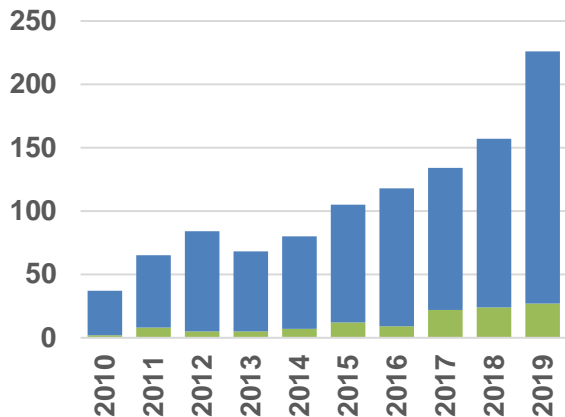
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Research question and hypothesis

3rd Energy Package EU (2009): EV and EP definition and measure

? Concept...

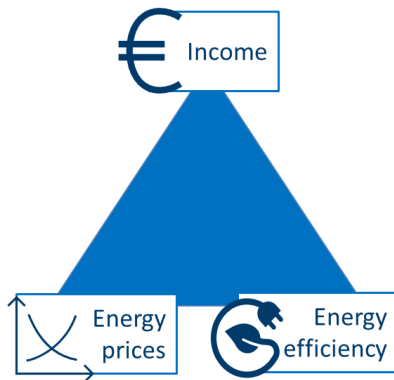
N. scientific publications/year



■ Household's Energy Poverty

■ Household's Energy Vulnerability

? ...analysis...



Indicators:

10%: excessive energy expenditure (absolute)

2M: excessive energy expenditure (relative)

M/2: insufficient energy expenditure (relative)

LIHC: excessive energy expenditure (relative)+poverty

? ...and policy-making


A "circular argument":

"...who is energy poor depends on the definition. but the definition depends on who you want to focus on and this involves political judgement."

[Boardman 2009]

Research question and hypothesis

A possible solution

- ❑ **Energy Vulnerability and Energy Poverty 2 faces of the same coin**
- ❑ **Interpretation: (ex-ante) EV  (ex-post) EP**

- ❑ **Centre the focus on the first one**
- ❑ **More formal characterization of Energy Vulnerability:**
 - Micro and macro (direct and indirect) determinants of people's energy use
- ❑ **Build a measure coherent with observed dimension of EP**

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Method and results

A methodological approach in three steps*

* Thanks to: Scarpellini et al. (2015), Primc et al. (2019), Camboni et al. (2020)

Step 1: HH level

Energy vulnerability variables into "risk" measures

Step 2: HH level

Econometric test: the relationship risk measures vs energy poverty

Step 3: Regional level

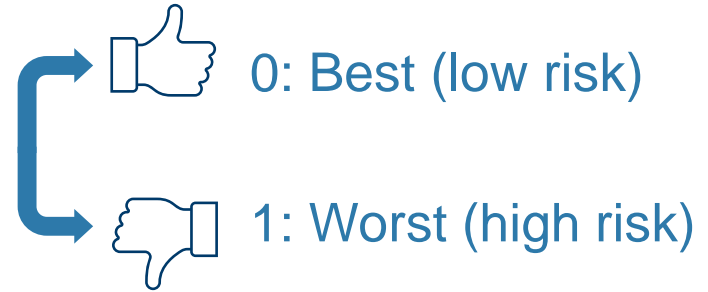
Construction of an energy vulnerability indicator (micro-; macro-based)

Method and results

A methodological approach in three steps

❑ Risk measure [0,1]:

- Range standardisation (max-min) s.t:



❑ Energy poverty index*

- LIHC-IT {
 - 1) Share of energy expenditure > 2 x (IT average)
 - 2) Net income < poverty line
 - 1) Heating expenditure = 0
 - 2) Income < (IT median)

*Faiella and Lavecchia (2014)

Method and results

Step 1: Variables selection (ISTAT – 2018 HES)...

Dimension 1: Personal characteristics (Household and components)*

Age H (5)	Components (5)	Children (6)	Education (5)	Tenure (4)	...and the 0/1
<35	1	0	None	Tenant/Sub.	Sex of H
35-54	2	1	Primary	Owner	Nation of H
55-64	3	2	Second, 1st	Usufruct	
65-74	4	3	Second, 2nd	Free use	
75+	5+	4	University+		
		5+			

* Number of distinct categories in (...). of aggregated categories in [...]

Method and results

Step 1: Variables selection...

Dimension 2: Housing

Building's age (9)	Square meters/component
<1900	<10
1900 – 1949	[10 - 20)
1950 – 1959	[20 – 30)
1960 – 1969	[30 – 40)
(...)	[40 – 60)
2000 – 2009	[60 – 100)
Afrer 2009	100+

Method and results

Step 1: Variables selection...

Dimension 3: Economic condition (Household and components)

Work H	Sources of income HH (9)	Current condition HH (4)	Income use (3)
Employed	None	Good	Savings > 0
Search of 1st...	Employer	Adequate	Savings = 0
Not employed	Self-employ	Inadequate	Savings < 0
House keeper	Pension	Insufficient	
Student	Rent		
Retired	Allowance		
	Support [2]		

Method and results

Step 1: Variables selection...

Dimension 4: Availability of basic home appliances

Dimension 5: Availability of ICT devices and networks access

Dimension 6: Availability of energy carriers

Basic appliances; Energy carriers	ICT network	ICT devices: Mobile/person	ICT devices: PC/person	ICT devices: TV/person
Fridge (Y, N)	Fixed line (Y, N)	<1	<1	<1
Washing (Y, N)	Internet (Y, N)	[1-2)	[1-2)	[1-2)
Dishwasher (Y, N)	Electricity (Y, N)	2+	2+	2+
Gas (Y, N)				
Electricity (Y, N)				

Method and results

Step 1: Variables selection...

Dimension 7: Water, heating, cooling and ventilation

Heating	Heating type	Heater fuel	Hot water	Hot water type	VAC
Yes	Centralized	Network gas	Yes	Electric	Yes
No	In-home	Kerosene	No	Gas	No
	Teleheating	Gas tank		Heating system	
	Single appliance	Biomass		Solar panel	
		Electricity			
		Solar panel			

Method and results

Step 1: ...and construction of a "risk" measures

Work H	Risk exposure	Current condition HH	Risk exposure	Sources of income HH	Risk exposure
Employed	0.5022	Good	0.0000	Employer	0.5022
Search first of 1st...	1.0000	Adequate	0.1336	Self-employer	0.4895
Not employed	0.9168	Inadequate	0.5639	Pension	0.4937
House keeper	0.7211	Insufficient	1.0000	Allowance	0.7815
Student	0.8291			Rent (RE)	0.0000
Retired	0.0000			Rent (financial)	0.4175
				Support (in HH)	0.9780
				Support (out HH)	0.7551
				No income	1.0000

Method and results

Step 2: Testing the relationship...

Full model: logit (p energy poverty) vs Energy vulnerability determinants

Parameter (Rob.SE) p -value	Parameter (Rob.SE) p -value	Parameter (Rob.SE) p -value
AgeH: 0.8294 (0.1922)***	WorkH: 0.7449 (0.1736)***	ICTNet: 0.6198 (0.1208)***
Components: 0.7437 (0.3001)*	IncFromHH: 1.6105 (0.32)***	ElecGas: 0.4301 (0.2176)*
NationH: 0.8515 (0.1399)***	EconCond: 0.523 (0.1579)**	HeatFuel: 0.8657 (0.2052)***
Sex H*Kids: 1.0667 (0.7046).	IncUse: 0.4718 (0.1311)***	VAC: 0.1809 (0.0905)**
EduMaxHH: 0.6494 (0.171)***	BasicDev: 0.6373 (0.2642)**	Period: 0.4149 (0.1598)**
Tenure: 0.4032 (0.098)***	ICTAppl: -0.4029 (0.2444)*	Surface: 1.1463 (0.3209)***

Method and results

Step 2: Testing the relationship...

Full model: logit (p energy poverty) vs Energy vulnerability determinants

Non-negligible effects at regional level

Piedmont: ***	Friuli-VG: *	Marche:**	Puglia: **
Aosta Valley: *	Liguria: ***	Lazio:**	Basilicata:
Lombardy:	Emilia-Romagna: *	Abruzzo: **	Calabria: *
Trentino-ST:	Tuscany: ***	Molise:	Sicily:
Veneto:	Umbria: *	Campania: **	Sardinia: *

Method and results

Step 3: Regional indicators, by dimension – The micro perspective

	Personal	House	Economy	Basic appliances	ICT	Energy	Utilities
Piedmont	0.2843	0.3514	0.4258	0.1532	0.5318	0.0456	0.4480
Aosta Valley	0.2763	0.3422	0.4427	0.1521	0.5468	0.2263	0.5670
Lombardy	0.2767	0.3501	0.4153	0.1332	0.5116	0.0107	0.2856
Trentino-ST	0.2945	0.3685	0.3610	0.1135	0.5461	0.1788	0.5133
Veneto	0.2729	0.3406	0.4103	0.1254	0.5296	0.0776	0.2371
Friuli-VG	0.2794	0.3386	0.4017	0.1726	0.5398	0.0822	0.3273
Liguria	0.2852	0.3484	0.4364	0.1546	0.4931	0.0308	0.4099
Emilia-Romagna	0.2824	0.3414	0.4093	0.1349	0.5116	0.0256	0.2477
Tuscany	0.2838	0.3570	0.4109	0.1240	0.4937	0.0599	0.3455
Umbria	0.2779	0.3561	0.4457	0.1245	0.5058	0.0801	0.4436
Marche	0.2830	0.4017	0.4447	0.1658	0.5355	0.0370	0.4039
Lazio	0.2826	0.3525	0.4561	0.1525	0.4734	0.0605	0.3246
Abruzzo	0.2682	0.3592	0.4585	0.1852	0.5632	0.0262	0.4202
Molise	0.2653	0.3473	0.4906	0.1781	0.5718	0.1137	0.4758
Campania	0.3015	0.3971	0.5220	0.2536	0.5444	0.1692	0.4597
Puglia	0.2842	0.3793	0.5064	0.2036	0.5952	0.0938	0.3233
Basilicata	0.2756	0.4000	0.4734	0.2043	0.5503	0.0990	0.4605
Calabria	0.2910	0.3913	0.5335	0.2364	0.5847	0.2604	0.4778
Sicily	0.2838	0.3889	0.5139	0.2491	0.5751	0.2232	0.3697
Sardinia	0.2843	0.3683	0.4877	0.2253	0.5368	0.4508	0.4582

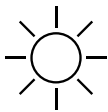
Method and results

Step 3: Regional indicators, by dimension – The macro perspective

Climate (Eurostat)



Heating degree-days (+)

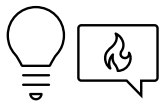


Cooling degree-days (+)

Market openness (ARERA)

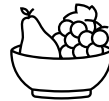


Market share big 3 (+)



Switching rates (-)

Global wealth (ISTAT)



GDP percapita (-)

Energy consumption (ENEA)



Final residential consumption (-)

Technological lead (EPO)



Granted patents EE (-)

Method and results

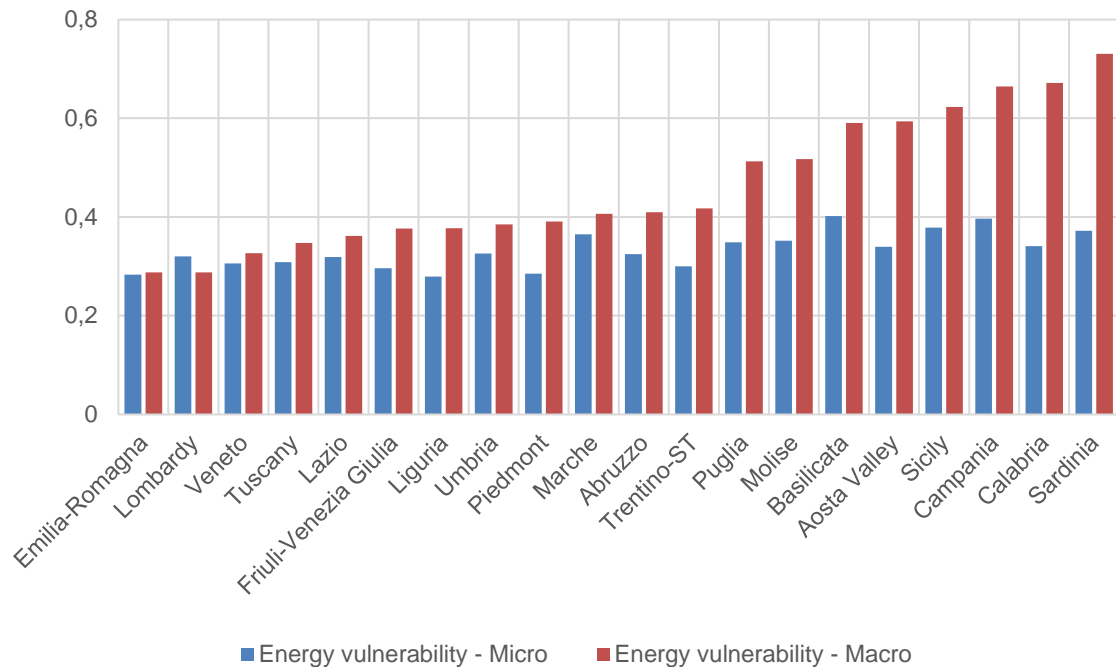
Step 3: Regional indicators, by dimension – The macro perspective

	Climate	Market openness	Global wealth	Energy consumption	Technological lead
Piedmont	0.3326	0.2400	0.4167	0.4183	0.1610
Aosta Valley	0.5000	0.8903	0.0717	0.0000	0.1642
Lombardy	0.4548	0.2043	0.4904	0.8600	0.0000
Trentino-ST	0.4351	0.8797	0.0605	0.1211	1.0000
Veneto	0.5638	0.2719	0.4951	0.6469	0.2333
Friuli-VG	0.2960	0.3821	0.4537	0.4805	0.1736
Liguria	0.3011	0.3376	0.6047	0.8158	0.1450
Emilia-Romagna	0.4749	0.5030	0.5221	0.8208	0.0074
Tuscany	0.2596	0.4428	0.5588	0.6995	0.2446
Umbria	0.1851	0.4275	0.4332	0.2042	0.3998
Marche	0.3342	0.3015	0.6579	0.7655	0.3455
Lazio	0.3564	0.4047	0.5747	0.8107	0.3326
Abruzzo	0.2456	0.2245	0.4886	0.3266	0.5804
Molise	0.4293	0.3317	0.5423	0.2510	0.7474
Campania	0.4763	0.2658	0.8816	0.8358	0.8667
Puglia	0.5388	0.4497	0.9163	0.9075	0.7808
Basilicata	0.3374	0.4230	0.5073	0.2542	0.8008
Calabria	0.4442	0.6603	0.6461	0.2921	0.9068
Sicily	0.3984	0.6990	0.9788	1.0000	0.8456
Sardinia	0.4737	0.5466	0.6490	0.4636	0.6925

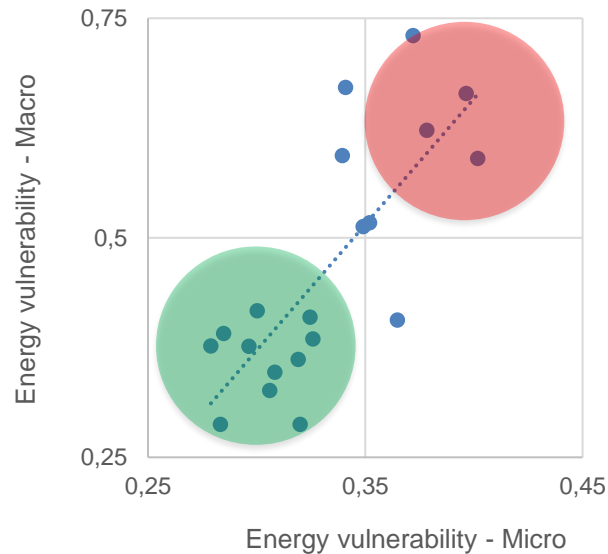
Method and results

Step 3: Regional indicators – Sythesis and test

Micro- and macro-indicator



Micro- VS macro-indicator



Method and results

Step 3: Regional indicators – Sythesis and test

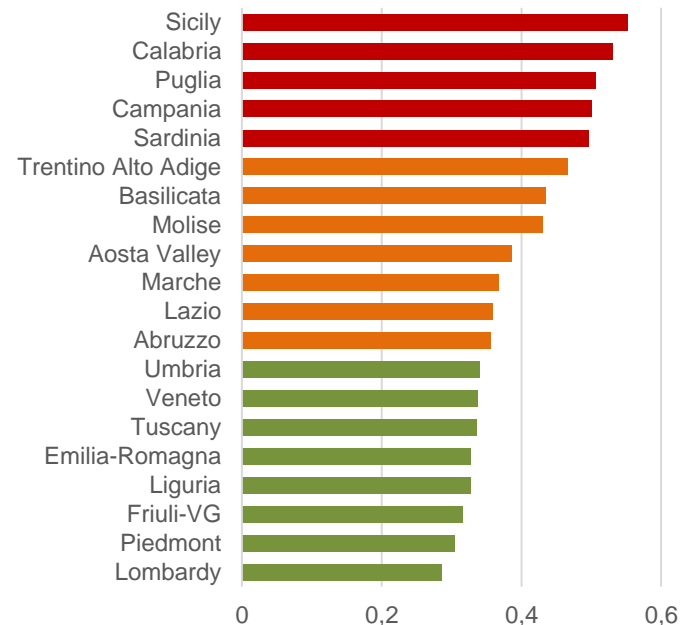
Parametric independence test (Pearson's correlation)

	2M	LIHC	10% Indicator	EEIQ-1	M/2	LIHC-IT
V-micro	-0.4583*	0.7132***	0.2277	0.2179	-0.3723	0.6655***
V-macro	-0.4340*	0.8051***	-0.0571	-0.0571	-0.4996*	0.8081***
V-general	-0.4569*	0.8173***	0.0047	0.0013	-0.4917*	0.8093***

Nonparametric independence test (Spearman's rank correlation)

	2M	LIHC	10% Indicator	EEIQ-1	M/2	LIHC-IT
V-micro	-0.4692*	0.6845***	0.2015	0.2814	-0.4301*	0.6376***
V-macro	-0.5414*	0.7206***	-0.0075	0.0128	-0.4602*	0.6677***
V-general	-0.5489**	0.7319***	0.0406	0.0813	-0.4556*	0.6692***

General indicator



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Closing remarks

In conclusion

❑ Achievements

- Representation of the EV multidimensionality
- Integration between micro and macro factors of risk
- Ranking of Italian regions

❑ Future developments

- Thorough understanding of the EV drivers
- Fine tune the computation of indicators

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